In the chapters on the temperature of the water he includes rivers, lakes, and seas, and gives a résumé of the numerous works done since the publication of the oceanographies of Boguslawski, Krümmel, and Thoulet. He mentions here a new, large volume by Professor Spyndler.

Chapters 6, 7, and 8 give the distribution of temperature in the earth's crust, having regard, first, to the surface layer of the crust; the arrangement employed for investigation; the daily and yearly gain and loss of heat; the influence of underground waters, rainfall, foliage of plants, etc.

Chapters 9 and 10 treat of the temperatures observed in oceans, lakes, and smaller bodies, mentioning the influence of winds. He gives the yearly curve and the types of temperature distribution. The distribution of salinity, surface temperatures, and currents in the great oceans is discussed, and the influence of shape and size of the ocean bed on the direction and velocity of the current is also considered.

Chapter 11 treats of the snow, ice, and icebergs.

Chapter 12 explains the temperature and humidity of the air (Assmann's ventilated psychrometer, maximum and minimum thermometers, Saussure's hygrometer, Wilds evaporimeter), and the evaporation of sea water.

Chapters 12 and 13 deal with the thermodynamics of the atmosphere, especially as illustrated by the results of the balloon work at Berlin and the theoretical investigations of von Bezold on the successive stages in the condition of an ascending current of moist air.

Chapters 14 and 15 treat of the vertical and horizontal distribution of the average temperature and humidity and their periodic and nonperiodic changes.

Chapter 16; the cloudiness and especially the kind of clouds.

Chapter 17; rain, snow, and hail.

Chapter 18; the study of atmospheric pressure, the instruments, the changes of pressure with time, diurnal periods, isobars, the reduction to sea level.

Chapters 19 and 20; the anemometer, the velocity of the wind, the Koeppen-Espy theory as to the diurnal periodicity of the upper and lower winds, the relation between pressure and wind, barometric gradients, etc.

Chapter 21; the general circulation of the air between the poles and the equator.

Chapter 22; the influence of the continents on the winds, the monsoons, and other local winds.

Chapter 23; the optical phenomena of the atmosphere.

Chapter 24; atmospheric electricity, its measurement, with especial reference to the new theories of ions of Arrhenius, Ekholm, and others.

Chapters 25, 26, and 27 treat of cyclonic storms and chapter 28 of thunderstorms.

Chapter 29 is devoted to climate. The treatise closes with chapter 30, describing the national meteorological bureaus, forecasts, observing stations, the hours of observation, and the international meteorological congresses.

The work is richly illustrated with diagrams and pictures, such as are used by Woeikof in his lectures at the university. At the end of each chapter Woeikof adds references to the literature of the respective subjects. The whole work is well adapted to the use of students in universities.

THE RESULTS OF THE WORK DONE AT THE AERONAUTICAL OBSERVATORY AT TEGEL, NEAR BERLIN, FROM OCTOBER 1, 1901, TO DECEMBER 31, 1902.[1]

By STANISLAV HANZLIK, Ph. D.

This second official publication of the Aeronautical Observatory near Berlin relates to fifteen months of work with kites, kite balloons, free manned and free sounding balloons. This report differs from the first in that the authors have abandoned the complete reproduction of all original curves and daily weather maps, which were formerly given with the view to the possibility of the practical application of aerial exploration to the daily work of forecasting.

Many troubles occurred after the military aeronautical battalion began its full service at the end of the year 1901. This battalion is quartered across the road just opposite the observatory at Tegel, and it often happened that the wires of the kite, when flying in the air, interfered with the lines of the kite balloons of the military battalion. Therefore the plan of flying the kites from the top of the kite tower built for this purpose was abandoned and, by means of a pulley, the kite wire was led from the reel in an opposite direction along the ground away from the observatory. Another disadvantage due to proximity to the city was experienced when the kite wires broke and fell on telephone wires or on lines conducting currents of high potential, causing many disagreeable and dangerous accidents, both in Berlin and the adjacent suburbs. For these reasons it has now been decided to remove this observatory still farther from Berlin, and a new location has been chosen in Lindenberg, 60 kilometers southeast of Berlin, where it is expected that a new series of ascensions will begin in April, 1905.

As regards the kites, as indeed I had occasion to see during my stay at Tegel, all kinds have been built and tried, not only the patterns proposed by members of this observatory, but those by other meteorologists in all parts of the world, and the balloon house at Tegel is a real museum of kites exhibiting the greatest variety of shapes and sizes. The observatory employs a carpenter, whose entire time is given to building and mending the kites. A wide experience with many patterns has shown that the great Hargrave kite, with curved front surfaces devised by Mr. Clayton of Blue Hill, is the best. For light winds kites of seven square meters of surface are used, but for the strongest winds those of six, four, or three square meters are used. For the very lightest winds, a delicate kite of aluminum tubes covered with silk, devised by Assmann, has been successfully flown. Recently the X kites devised by the assistant of the observatory, Mr. Mund, have been used. They are of the Hargrave pattern, but easily fold up flat for convenience of transportation, and are used therefore as auxiliary for holding up the kite line. The advantage of folding up is apparent when the kites in high winds tear away or are automatically released and carried far away.

As regards kite balloons, it is found that when they are frequently used the balloon fabric becomes useless within a half year, making them very expensive when we recall that a kite balloon of 68 cubic meters capacity costs 1300 marks.

As regards the self-registering instruments, Professor Marvin's kite meteorograph proved to be a satisfactory working instrument up to the height of 2500 meters for which it was designed; but a considerable correction must be applied if one wishes to use it at higher elevations. In fact, the first great height attained at Tegel, December 6, 1902, as computed from the original barograph curves, gave 5475 meters, but a subsequent very careful investigation reduced this height to 4820 meters. The sharpness of the curves given by the Marvin meteorograph is injured by the oscillations of the kite, unavoidable in strong winds, but the curves were much improved by an arrangement devised by Doctor Elias, who fastened the meteorograph by springs to the front cell of the kite, thus shielding it from shocks and vibrations. Marvin's electrically-registering anemograph worked with much uncertainty and often entirely stopped. Moreover, being exposed on top of the kites, it was often injured and the friction coefficient changed thereby. For this reason some columns given in the present volume are left entirely blank as to the wind velocity. As an improvement, Professor Assmann has applied the Woltmann vanes (like the vanes of an electric fan). The

[1] Ergebnisse der Arbeiten am Aeronautischen Observatorium, October 1, 1891, bis December 31, 1902, von R. Assmann u. A. Berson.

framework carrying these small vanes is attached to the front of the opening of the Marvin meteorograph. The vanes are calibrated by comparison with an anemometer, and must be recalibrated from time to time.

For use with his expansible India rubber sounding balloons, or Platz balloons, Assmann invented a very light meteorograph. To this end he adopted an endless roll of gelatinized Japanese silk paper. This endless roll passes over two small aluminum rollers, of which the upper one is moved step by step by the aneroids, which act on ratchets attached to either end of the upper roller, while a weight on the lower roller keeps the sheet stretched smooth. The thermometer is a metallic one, consisting of two circular plates of metal, copper and invar (Guillaume's nickelsteel), soldered together. The motion of the free end of this compound ring is magnified by levers, which eventually move a delicate silk thread running over a wheel so that its recording pen marks the temperature curve on the sheet of silk at right angles to the direction of its motion. This pen describes a nearly closed curve from the beginning to the end of any ascension, which curve is a function of the pressure and temperature. The thermograph and the hair hygrometer are inclosed in a vertical polished aluminum tube, which protects them from direct solar radiation. When the balloon falls to a pressure of about 600 millimeters, the pens are mechanically lifted and their record ceases. This arrangement has the advantage that we may thus clearly discriminate between the ascending and the descending curves; it also preserves the whole record from injury or other damage when the kite falls to the ground, especially if the instrument remains a long time in the open air and is tossed about by the winds. In order to know whether the balloon actually bursts or how long it floats at a high level, exposed to the sunshine, there is added a clock, which also makes a record on the same sheet. This new form of meteorograph is inclosed in a box of magnalium; it weighs 620 grams and can be furnished for 360 marks by R. Fuess, Steglitz.

In order to measure the angular altitude of a kite carrying a meteorograph a special apparatus was used; a Steinheil astronomical telescope with a large field of view and a pair of cross wires in the center was furnished with horizontal and altitude circles reading to 0.1°; a self-recording apparatus was contrived so that this really constituted a "goniograph." The observer has only to keep the cross wire pointed on the balloon or kite as closely as possible, and the apparent altitude and azimuth are simultaneously recorded on two sheets of paper from time to time. At the new observatory at Lindenberg it is proposed to keep two of these goniographs at work, at the ends of a short base line, in order to calculate the location of kite or balloon at any moment.

The work at Tegel is to be considered as preliminary to future work. Four hundred and seventy-five ascensions were made, of which 356 occurred during the fifteen months whose results are published in the present volume. They may be classified as follows:

(A) Fifteen ascensions of manned balloons; of these the longest voyage was 1470 kilometers in twenty-nine hours to the government of Poltava, in southern Russia, by Professor Berson and Doctor Elias; the highest ascent was 7832 meters.

(B) Twenty-two ascensions of free sounding balloons of the Assmann type, one of which was lost. The average altitude attained by 21 of these was 9816 meters. The average of the 17 highest was 11,157 meters, 3 rose above 19,000 and the maximum was 19,960 meters.

(C) Two hundred and five kite-balloon flights and (D) 103 kite flights. The excess in the number of flights of kite balloons was due largely to the fact that Doctor Elias was engaged in his study of the formation of fogs and also to the fact that at first there was no great familiarity with the management of kite ascents; but all this was changed in August, 1902, when Professor Assmann ventured to start with daily flights in any kind of weather, and the use of kite balloons was then reduced to a minimum. Under these conditions very often a kite ascent was accomplished when at first sight it seemed impossible on account of the feeble winds near the surface. In such cases by unrolling several hundred meters of wire, laying it out in the direction of the feeble wind, attaching the kite and reeling in with great speed, they produced an "artificial" wind, which increased the actual wind so that the kites were thrown up into a stratum of air of greater velocity. But very often the trees around the observatory prevented such experiments. In a similar way when much line had been played out and the kites, owing to the feeble upper wind, did not rise high, they were forced to rise higher by reeling in rapidly. Frequently when the kite was caught in the top branches of a tree it was necessary for an archer to shoot a light arrow carrying a light line over the tree; by this line a stronger one was drawn up and over, so that one could climb up to the kite and rescue it, or at other times the balloon was used to lift the kites from the trees.

As regards the personnel of the observatory it may be said to consist of the director, Professor Assmann, the permanent assistants, Professor Berson and Doctor Elias; and clerical work is done by Messrs. Dintner, Brehm, Koercke, and Koblenz.

The most expert mechanician, Thieme, was continually engaged in building and repairing the meteorological and other instruments, while R. Schmidt and W. Mund usually assisted during the kite flying, and F. Schmidt acted as balloon inspector. A carpenter was also continually employed, as mentioned above, in building and mending the kites.

The observatory at Tegel constituted a division of the Central Meteorological Office. But it is understood that the new establishment at Lindenberg will be an entirely separate institution for aerial research under Professor Assmann.

Appended to the record of kites and balloons is a paper on the formation of fogs by Doctor Elias that was translated in part by Mr. Proctor for the MONTHLY WEATHER REVIEW for September, 1904.

A second appendix by Berson and Elias gives the results of kite flying over the Baltic Sea, the North Sea, and Norwegian waters. These flights were made during their vacation excursion to Spitzbergen on the steamer *Oihonna.* On this occasion all the instruments and kites were supplied by the Tegel Observatory in order to practically test the well-known idea of Mr. Rotch as to the possibility of flying kites on the open sea from ships. Mr. Dines and Teisserenc de Bort had also done some work in this line following the idea of Mr. Rotch, and quite recently the Prince of Monaco has done so near the the Azores, according to the report of Professor Hergesell to the International Aeronautical Congress held last year, 1904, in St. Petersburg. On the Bodensee, in Switzerland, Hergesell and Zeppelin have also used a steamboat with success. Ascensions were made by Berson and Elias nearly every day from August 3 to 29 from the steamer *Oihonna,* and the results are given in full, showing in general that this method can be applied everywhere.

EVAPORATION OBSERVATIONS IN THE UNITED STATES.

By HERBERT HARVEY KIMBALL, Librarian, U. S. Weather Bureau.

[Read before the Twelfth National Irrigation Congress at El Paso, Tex., November 16-18, 1904.]

It is important that irrigation engineers should know not only the rainfall, but also the evaporation over any given region. Unfortunately, the measurement of evaporation presents many more difficulties than the measurement of precipitation. In fact, the rate of evaporation from land surfaces depends upon so many different elements that it can be treated only in the most general manner. Thus, it has been shown that the